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VisiOmatic 2: a Web Client for Remote Visualization With Real-time Mixing of Multispectral Data

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Abstract. VisiOmatic (Bertin et al. 2015) is a JavaScript client built on top of the Leaflet library for visualizing extremely large scientific images in regular web browsers. We present version 2 of VisiOmatic, which offers a number of enhancements, including real-time mixing of multispectral datacubes. VisiOmatic is embeddable in regular Web pages, blog posts, portals, or wiki entries. It is compatible with touchscreen interfaces such as those offered by iOS and Android mobile devices. The position and appearance of widgets is fully customizable through module options and Cascading Style Sheets.

1. Introduction

The ever-increasing acquisition rate of imaging surveys and the prevalence of fully automated data analysis algorithms make image visualization less and less a tool of discovery. Still, visual examination remains necessary for quality control or morphological analysis. For developers, image inspection also plays a critical role in the tuning and debugging of algorithms. Moreover, delivering beautiful (while scientifically accurate) images of the sky in public conferences, in press releases or simply on the net has a strong educational and social impact, as it potentially touches millions of viewers (e.g., Nemiroff & Bonnell 1995; Goodman et al. 2011).

The development of wireless networks and light mobile computing (tablet computers, smartphones) has changed the way astronomers access image data, and image analysis and inspection are now often being carried out outside of the office environment. Astronomers involved in international collaborations must interact remotely, often in real-time, with colleagues and data located in different parts of the world and in different time zones. In this context, classical visualization tools are not well suited to the task of browsing and inspecting large amounts of image data located on remote servers, especially when those images are actually data-cubes.

VisiOmatic 2 helps bridging this data gap by offering interactive image visualization with multi-channel "pixel peeping" capabilities inside a web browser, without any plugin. It may be used in regular web pages or embedded in science portals, for professional astronomers or for public outreach.

2. Server-side technology

Our viewer relies on the proven "slippy map" technique for displaying and interacting with very large images. But instead of using pre-computed JPEG tiles, mixing of the various data planes, gamma correction and JPEG compression are performed on the fly server-side, using an optimized version of the IIPImage server (Pillay 2014). IIPImage is able to saturate a 1GB/s connection with JPEG data on a single server node with 12 midrange CPU cores (Bertin et al. 2015).

Data-cubes are stored as "tiled image pyramids", where vectors of pixels in each sub-image are successively rebinned 2×2 along the spatial dimensions. The STIFF package (Bertin 2012) may be used to convert a set of FITS images to a tiled pyramid in integer or floating point format, stored as a single file on the server.

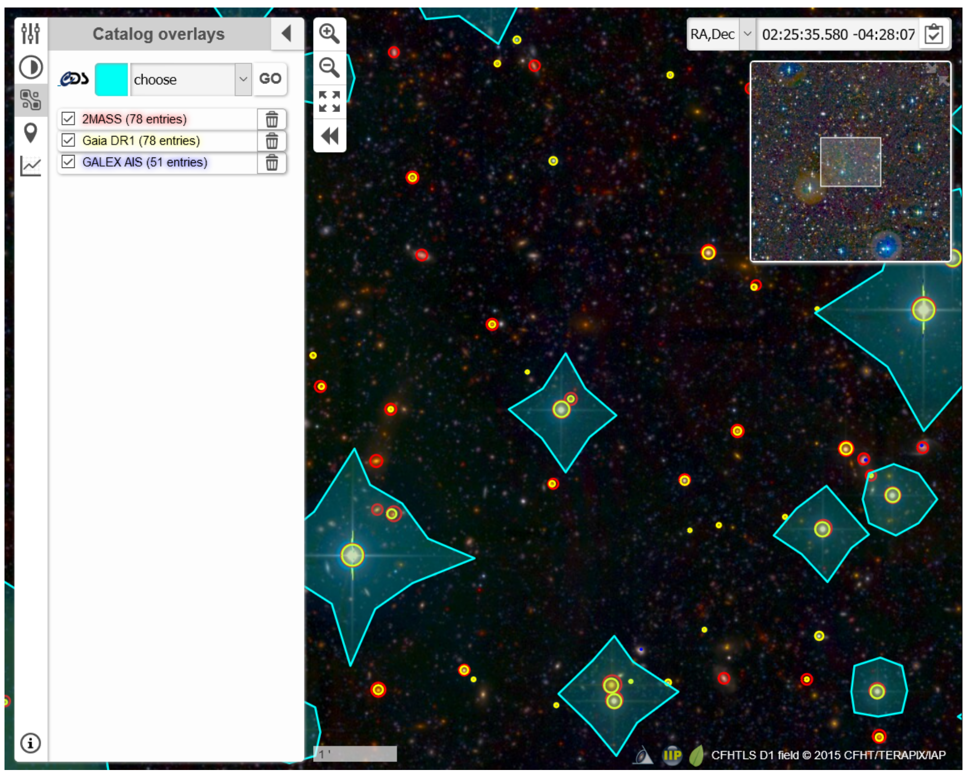

Figure 1. Examples of VisiOmatic catalog and region overlays in the CFHTLS D1 field (Hudelot et al. 2012).

3. Client-side technology

VisiOmatic operates as an advanced Leaflet plug-in written in JavaScript, and as such comes bundled as a NodeJS package. The Leaflet library (Agafonkin 2014) provides all that is needed to build a GIS (Geographical Information System) web client for browsing interactive maps with overlays. Celestial / Ecliptic / Galactic / Supergalactic coordinates are managed through a JavaScript library of our own, implementing a subset of the WCS standard (Calabretta & Greisen 2002) and fitted into Leaflet's native latitude-longitude coordinate management system. Several images can be synchronized on screen even if they do not share the same pixel scale or even the same projection.

VisiOmatic takes advantage of Leaflet's high-level vector layer features and built-in GeoJSON support to provide interactive catalog and region overlays, as well as plotting (Fig. 1).

Center coordinates and field-of-view can be provided during layer initialization in VisiOmatic, and bookmarked as a URL query string. This URL mechanism is a simple and powerful alternative to the traditional web links to (static) image cutouts that accompany some source catalogs.

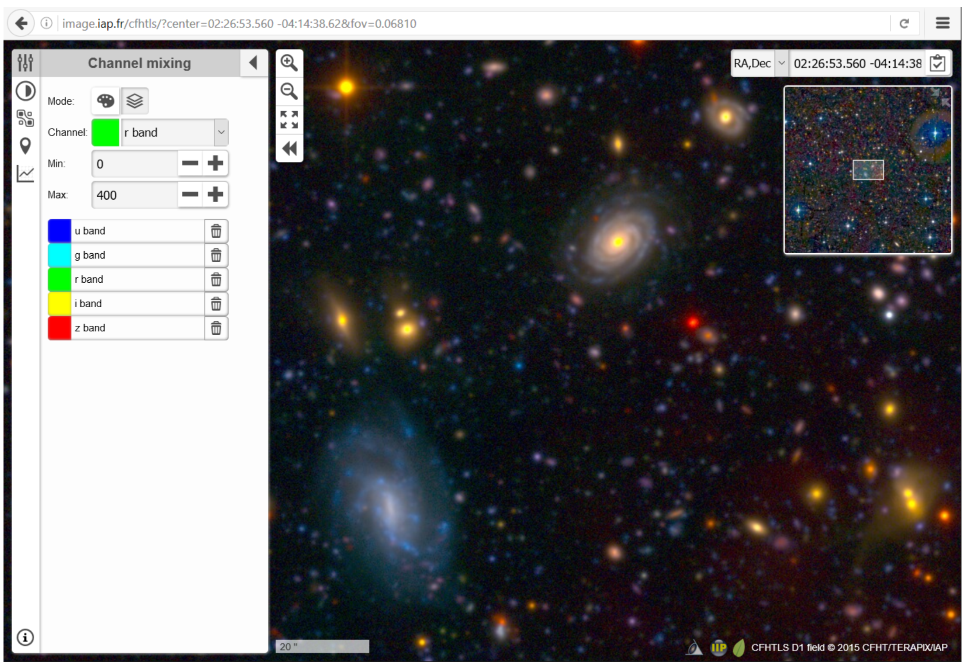

Figure 2. VisiOmatic's color mixing menu, showing the various colors assigned to each channel of the image datacube.

4. Color mixing

Prior to gamma compression, the Red, Green, Blue color mix applied to n-channel image pixel $\boldsymbol{p}$ is determined by the mixing matrix $\mathbf{M}$ sent by the client to IIPImage:

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \mathbf{M}\boldsymbol{p} \tag{1}$$

VisiOmatic computes the mixing matrix from a combination of intuitive controls in the web interface that can be adjusted in real-time by the user (Fig. 2). $\mathbf{M}$ is the product of a color saturation operator **S** and a channel color operator **C**, **M** = **SC** with

$$\mathbf{S} = \begin{pmatrix} 1+2\alpha & 1-\alpha & 1-\alpha \\ 1-\alpha & 1+2\alpha & 1-\alpha \\ 1-\alpha & 1-\alpha & 1+2\alpha \end{pmatrix} \quad \text{and} \quad \mathbf{C} = \begin{pmatrix} r_1 & r_2 & & r_{n-1} & r_n \\ g_1 & g_2 & \dots & g_{n-1} & g_n \\ b_1 & b_2 & & b_{n-1} & b_n \end{pmatrix}. \qquad (2)$$

Parameter α sets color saturation (0 for black & white, > 1 for exaggerating colors), and (r_c, g_c, b_c) is the normalized, gamma-expanded color vector assigned to channel c.

5. Conclusion

We have presented VisiOmatic 2, a customizable web client for visualizing large multi-channel astronomical images. The code is released under the BSD license[1]. Installation and configuration instructions, as well as a complete API description can be found on the VisiOmatic website[2] and in the online documentation[3].

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[1] http://github.com/astromatic/visiomatic

[2] http://visiomatic.org

[3] http://visiomatic.readthedocs.io